[0016] **FIG. 6** is a front view of a hinge portion of an orthotic bracing element.

[0017] **FIG. 7** is a side view of a bracing element of an orthotic brace and a loading transducer arranged to effect rotation of the levers of the bracing element.

[0018] **FIG. 8** is a side view of a bracing element of an orthotic brace and an alternative loading transducer arranged to effect rotation of the levers of the bracing element.

[0019] **FIG. 9** is a sectional schematic of a magneto-rheological linear transducer.

[0020] **FIG. 10** is a perspective view of an adjustable orthotic sleeve brace.

[0021] **FIG. 11** is a side elevation of a polymer-metal composite transducer.

[0022] **FIG. 12** is a side view of a bracing element of an orthotic brace and including a polymer-metal composite loading transducer arranged to effect rotation of the levers of the bracing element.

[0023] **FIG. 13** is a side view of a shoe based bracing system.

DETAILED DESCRIPTION OF THE INVENTION

[0024] A typical orthotic brace comprises generally a joint stabilizing bracing element and a plurality of attaching elements to bind the bracing element to the soft tissue of the limb elements, above and below a joint. **FIGS. 1 and 2** illustrate an exemplary orthotic knee brace **20**. The bracing element comprises generally of a pair of levers including bars connected by a hinge structure. Thus, the exemplary knee brace **20** includes a femur lever, generally designated, **22** and a tibia lever, generally designated, **24**. The levers **22** and **24** are operatively connected at the lateral side of the leg proximate the knee by a hinge structure **26**. The hinge structure permits the distal ends of the femur lever **22** and the tibia lever **24** to be displaced relative to each other as the joint is flexed. The movement of the distal ends of the levers of an orthotic brace is substantially relative rotation in a plane, however, monocentric, bicentric, and polycentric hinges are utilized in orthotic braces to more precisely conform the lever displacement to the often complex articulation of specific joints.

[0025] The femur lever **22** comprises a generally elongated, flat femoral side bar **26** that extends generally longitudinally along the lateral or outer side of the thigh **28** and a plurality of spaced apart femoral side bar attaching elements **30** and **32**. Similarly, the tibia lever **24** comprises an elongated, flat tibial side bar **34** located generally longitudinally along the lateral or outer side of the calf and a plurality of spaced apart tibial side bar attaching elements **36** and **38**. The levers of some braces for the knee, elbow, and other joints include pairs of hinged bars, typically arranged generally longitudinally along opposite sides of the limb, these being a lateral or outer side bar and a substantially similar medial or inner side bar on the inside of the limb.

[0026] The exemplary knee brace **20** is attached to the limb elements, the femur, above the knee, and the tibia, below the knee, by a plurality of attaching elements that constrain the levers to the soft tissue of the limb elements. The femoral side bar **26** is bound to the femur at its distal end by a first attaching element, an upper thigh cuff **30**, that servers as a fulcrum for the femur lever. The upper thigh cuff **30** of the brace **20** comprises a cuff base **40** that is rigidly attached to the femoral side bar **26** and an upper thigh binding **42** having ends operatively connected to the cuff base. The upper thigh binding **42** is wrapped around the thigh and constrains the cuff base and femur lever **22** to the thigh. Similarly, another attaching element, the lower calf cuff **38**, comprising a cuff base **46** and a lower calf binding **48** serves as the fulcrum of the tibia lever **24**.

[0027] The upper thigh cuff base **40** is preferably substantially rigid and often formably adjustable to accommodate thighs of differing curvatures. A substantially rigid but formably adjustable upper thigh cuff base **40** can be fashioned from a metal core, preferably of aluminum, laminated on both sides with a covering, typically plastic, to protect the wearer and others from sharp edges or corners and improve wearer comfort.

[0028] The lower calf cuff base **46** typically comprises a flexible plastic, such as polyethylene. A flexible lower calf cuff base **46** is generally desirable to accommodate a variety of calf girths and permit adjustment of the tibial side bar **34** to prevent twisting relative to the hinge **26** which might otherwise be caused by calves that are undersized or oversized for the lower calf cuff base.

[0029] The attaching element of the femur lever **22** adapted to apply a reaction force to the femur proximal the knee joint is an adjustable lower thigh tensioning structure **32**. Likewise, an upper tibial tensioning structure **36** applies the reaction force to the tibia proximal the knee joint. The lower thigh tensioning structure **32** and the upper tibial tensioning structure **36** of many braces comprise a binding that passes around the leg and the bracing element to bind the bracing element to the limb element. In the exemplary brace **20**, the lower thigh tensioning structure **32** comprises a fabric binding **50** wrapped around the leg and the outer side of the bracing element **22**. An anterior thigh pad **52**, held in position by the binding **50**, spreads the load produced by the binding over a greater area the soft tissue of the thigh.

[0030] The upper tibial tensioning structure **36** is similar in construction to the lower tibial cuff **38** and comprises a flexible plastic cuff base **54** affixed to the tibial lever **34** and extending across the anterior of the tibia. The tensioning structure **36** includes a fabric binding **56** that passes through elongated eyelets **58** in the plastic cuff base **34**.

[0031] Lateral force can be applied to the knee by tensioning the bindings **50** and **56** of the lower thigh tensioning structure **32** and the upper tibial tensioning structure **36**. Tension in the bindings pulls the distal ends of the femur and the tibia, respectively, toward the bracing element **22** and applies a positive differential force couple to the femur and tibia proximal the knee joint. By adjusting the tension in the bindings of the tensioning structures, the compartmental loading or the relative portions of the load on the joint supported by the medial and lateral sides of the joint can be varied to protect compartments of the joint and treat certain joint conditions. A condyle pad may be placed between the hinge and the knee to bear against the side of the knee to control lateral knee instability. The surfaces of the brace in contact with the wearer are commonly covered by a fabric surfaced foam material **58** for wearer comfort and protec-